



SCHOOL OF SCIENCE AND MATHEMATICS

8th Annual

Student Research Poster Display

April 15-22
Caputo Hall Lobby

- **BIOLOGY** •
- **CHEMISTRY** •
- **COMPUTER SCIENCE** •
- **EARTH SCIENCE** •
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Note: The names of Millersville University faculty advisors are designated by an asterisk (*) in the abstracts.

Biology

1. **Doliolid Seasonal and Depth Distributions by Stage Along a 30 km Transect Off the Coast of Wallops Island, Virginia**

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Doliolids, which are a class of pelagic tunicates, can exhibit large aggregations dominated by chains of individuals, the result of asexual reproduction. Due to their wide size range of non-specific grazing, doliolids pose a potentially high impact on the abundance of phytoplankton. Abundant doliolids were found in zooplankton sampled at three depth intervals with an 80um Tucker trawl along a 5 station, 30 km transect offshore of Wallops Is., VA. *Dolioletta gegenbauri*, the dominant species, was observed in relatively high seasonal densities (up to several hundred per cubic meter) at the more offshore stations. They were found primarily from late August through early October in 2006 and 2007, with highest densities below the thermocline where phytoplankton concentrations were usually greatest. These trends will be documented for specific stages of *D. gegenbauri* to determine trends in stage abundances. Although high abundances of doliolids have been well studied in South Atlantic Bight waters, our study is the first to document doliolid blooms farther north in the southern Mid-Atlantic Bight.

2. **Comparative Pectoral Fin Anatomy of Batoid Fishes**

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Among Chondrichthyan fishes, batoid fishes have unique dorsal-ventrally compressed bodies and expanded wing-like pectoral fins that are attached to the head. This unique body design is adapted for a pelagic as well as a benthic existence. The external shape of the wings differs between species and also within families which allows for different modes of swimming (undulation, oscillation, or a combination of the two). The skeletal anatomy of 11 different species of batoid fishes, including both skates and rays was analyzed. This investigation describes the skeletal anatomy of the pectoral girdle and fins, as well as the arrangement of radial elements that make up the pectoral fins. These different anatomical patterns are related to the mode of swimming and external wing shape. Additionally the basal elements of the pectoral fin are highly variable within and between families, as well as the attachment and arrangement of radial elements relative to the basal elements. It is likely that these arrangements and attachments are phylogenetically important.

3. Comparison of the Contribution of Copepods, Tunicates and Cladocerans to the Biomass of Summer Herbivores in the Southern Mid-Atlantic Bight

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Previous studies have focused on copepod densities in the Mid-Atlantic Bight. Fifteen stations were sampled by vertical tows with an 80um mesh net in July 2006 from Delaware to Chesapeake Bays. Copepods, tunicates and cladocerans were the dominant herbivorous taxa in terms of density. Biomass was estimated for the most abundant species in the three taxa to compare the impact of the copepods versus the cladocerans and tunicates. Using photographic software (ACT-1) and image analysis (Image J), lengths were measured and placed into species specific length/weight regressions to obtain the mass per organism. The average mass was then multiplied by the density to create a biomass per cubic meter. The data showed that cladocerans represented an average of 38% of the biomass and were found predominately offshore. Copepods collectively accounted for 51% of the biomass and dominated the vast majority of the near shore stations and all stations off Delaware Bay. The tunicates amassed the other 11% which was distributed among stations offshore of Chincoteague and Chesapeake Bays. Cladocerans and tunicates graze smaller phytoplankton sizes in comparison to copepods. Since small phytoplankton tend to dominate during the summer, cladocerans and tunicates may have a greater grazing impact than the copepods.

4. Discrimination Learning of an Instrumental Task by *Octopus bimaculoides*

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Research indicates that the octopus is also a skillful learner; it can learn quickly and retain information in the laboratory setting. Octopuses have both long and short term memory and are capable of both visual and tactile discrimination. Previous studies have shown that octopuses can learn to put their arm in a tube to obtain a reward, a form of instrumental conditioning. The following study tested whether *Octopus bimaculoides* could learn to respond instrumentally to a perceptual cue. In the first step, the octopus was trained to put its arm in a tube for food. The complexity of the tube's shape was increased progressively, and eventually a light was added such that food was accessible in the tube only when the light was turned on. Six out of the fourteen octopuses were able to associate the light with food in the tube. The first sign of this connection occurred between 9-52 trials. One octopus demonstrated this association even when the final tube was left in its tank at all times. Results demonstrate that octopuses are capable of learning to associate a perceptual cue with an instrumentally conditioned response and provide further evidence of convergence between cephalopods and vertebrates.

5. Comparative Study of the Delivery of Albuterol via Homemade and Commercially Produced Spacers

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Metered-dose inhalers (pMDIs) are more effective when used in combination with a spacer by decreasing particle size, reducing deposition in the oropharynx and increasing the amount of medication available to the lungs. **OBJECTIVE:** The purpose of this study is to compare the performance of homemade spacers to commercially produced spacers. **METHOD:** Five types of homemade spacers made from 291ml, 500ml and 1000ml plastic bottles, paper towels rolls and toilet paper rolls were compared to a non-valved spacer (ACE), valved spacer (Optichamber Advantage), a non-electrostatic spacer (Vortex) and a pMDI without a spacer. A ventilator-driven spontaneous breathing lung model was set to deliver an inspired volume of 2.1 L, mean inspiratory flowrate of 22.42 L/min. Two puffs of albuterol were actuated into the spacers at the onset of inspiration and collected on in-line filters. The drug particles were eluded off the filters using methanol in a sonicator then quantified using UV Spectrophotometry at a detection wavelength of 275nm. A standard curve was created by diluting a stock solution to obtain the linear regression line equation. The equation was used to determine the concentration of drug from each filter. Each type of spacer was tested eight times, using a new spacer for each trial. The plastic bottles were washed with detergent to eliminate electrostatic charge. **RESULTS:** The 500ml and 291ml plastic bottles and the paper towel roll made significantly more drug available to the lungs than the three commercial spacers tested ($p < 0.05$). **DISCUSSION:** These data suggest homemade spacers are more efficient than commercial spacers for drug delivery from a pMDI when optimized technique is employed. It is acknowledged that valves in commercial spacers are helpful when optimal technique is not employed.

6. Genome-wide and Expression Analysis of Protein Phosphatase 2C in Rice and Arabidopsis

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The protein phosphatase 2Cs (PP2Cs) have been implicated as regulators of various signal transduction pathways involved in diverse environmental stress responses and developmental processes. In this study, all PP2C genes in the two important model plant species, *Arabidopsis thaliana* (mouse-ear cress, a dicot) and *Oryza sativa* (rice, a monocot) were identified, classified into subfamilies, and compared. The expression patterns of the PP2Cs from rice and *Arabidopsis* and their upstream regulatory regions were analyzed and compared. Additionally, potential gene birth-and-death events as well as gene duplication events that likely contributed to the expansion of the PP2C family were traced. This comparative, genome-wide overview of the PP2Cs was the first attempt to provide a timely,

complete overview of the PP2C gene family in *Arabidopsis* and rice. Importantly, this study provides insights into the functions and regulatory mechanisms, as well as the evolution and divergence of the PP2C genes in dicots and monocots. Our results have established a solid foundation for future studies on the functional divergence in different PP2C subfamilies. Such understandings will ultimately lead to innovations in agricultural research enhancing the quality and quantity of agricultural production.

7. *Hyphantria cunea* Feeding Behavior and Survivorship is Strongly Inhibited by *Ailanthus altissima*

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The anti-herbivory properties of *Ailanthus altissima* (Tree of Heaven) leaf tissue were investigated through larval feeding experiments conducted on *Hyphantria cunea* (fall webworm), a generalist herbivore that feeds on a variety of deciduous trees including *Juglans nigra* (black walnut), *Prunus serotina* (black cherry), and *Morus rubra* (red mulberry). Choice larval feeding studies using fresh *Ailanthus altissima*, *Juglans nigra*, and *Prunus serotina* leaf tissue showed a clear avoidance of *Ailanthus altissima* leaf tissue as demonstrated by reduced consumption. Forced larval feeding studies conducted in the same manner confirmed the anti-herbivory properties of *Ailanthus altissima* as indicated by 5 % mean leaf consumption of *Ailanthus* with a 19% larval mortality rate, as opposed to 80 % mean leaf consumption with a 0% mortality rate for the other tree species. Forced larval feeding studies using fresh *Juglans nigra* leaves coated with water soluble *Ailanthus* leaf extract exhibited a 60% mean mortality rate as opposed to a 2% mean mortality rate in untreated *J. nigra* leaves. Experiments regarding the anti-herbivory properties of *Ailanthus* on other Lepidoptera species are in progress. In addition, we are currently investigating the biochemical characteristics of the anti-herbivory components in *Ailanthus* leaf tissue.

8. An Unbiased Stereological Estimate of the Number of Motoneurons in the Rat Cervical Enlargement

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The number of motoneurons in the cervical enlargement (C4-T1) of the rat (Sprague-Dawley) spinal cord was estimated using a stereological technique called the physical fractionator. This procedure relies on a systematic, uniform random sampling of section pairs to form disectors, thus assuring an efficient and unbiased result. In this study, each disector consisted of two adjacent spinal cord sections stained with cresyl violet. A compound microscope with a drawing tube attachment was used to mark the location of all putative motoneurons with respect to the ventral horn boundaries. The mean number of motoneurons found unilaterally [6 spinal hemicords (3 left and 3 right)] in the rat cervical enlargement was estimated to be 7028 with a standard deviation of 222. The coefficient of error was 0.013. There appeared to be a bimodal distribution of motoneuron numbers in the rostral-caudal direction. The quantification of motoneurons in the rat cervical enlargement may serve as a useful basis of comparison for future experiments on developmental, disease, and aging processes.

9. The Detection of Wild Game DNA in Maggot Tissue

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Our research involved the development of protocols and methodologies to determine if wild game DNA could be isolated and sequenced from carrion-feeding fly larvae at different stages of development. The analysis of insect tissue for the presence of animal/bird DNA may provide another technique useful in wild game management and conservation. Three species of carrion-feeding flies were reared on approximately 350 g of wild game liver (deer, bear, coyote). Maggots were collected mid-molt from each larval instar (1st, 2nd, 3rd instars), preserved and shipped to the Wildlife Forensic Laboratory for extraction and DNA sequencing. Maggot tissue sectioning and DNA extraction was performed using the MoBio Ultraclean Tissue Extraction Kit. Amplifications were performed using Promega PCR Master Mix. The success of the PCR reaction was determined using an agarose yield gel stained with ethidium bromide. Following the Post ExoSap, the PCR product was ready for DnA seqencin. Sequencing methods followed Big Dye3.1 Qiagen DyEx Cleanup and AB 3130 protocols. Sequences were aligned and edited using Sequence Navigator software. We were successful in isolating DNA from all liver samples. Amongst all taxa tested, significantly more DNA was detected in *Calliphora vicina* larvae (ANOVA; F Stat = 7.37; P < 0.01). Developmental age of the maggot species tested did not affect the isolation and sequencing of wild game DNA. It appears that more DNA was detected in older (larger) *Lucilia cuprina* and *Sarcophaga haemorrhoidalis* larvae. We were able to isolate and sequence DNA from all three species of wild game and from all three fly species. We obtained a maximum identification score of 98% for the mitochondrial sequence examined in White-tailed deer. This study was the first to document the isolation and sequencing of wild game DNA from maggot tissue and demonstrate the potential in prosecuting wild game poaching cases in court.

10. A Simple Demonstration of Learning in *Paramecium*

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Research using invertebrate model systems has yielded remarkable insight into the cellular mechanisms of learning and memory. The present study shows a learned response in a singled celled organism that lacks a nervous system.

Paramecium caudatum is a slipper shaped, unicellular organism measuring about 250 µm in length that utilizes cilia for locomotion. Previous experimentation has shown that *P. caudatum* is attracted to a mild cathodal stimulus. This study couples this phenomenon of cathodal attraction with differential lighting to demonstrate learning in small groups of paramecia.

A microscope concavity slide was fitted with stainless steel electrodes at opposite ends of the well. Approximately 20 paramecia were placed in the well in ~100 µl of Sonnenborn's culture medium. During a three minute training session one half of the well was illuminated (3,150 lux) and the other half was shaded with black felt and an electrical stimulus was

applied (6.5 V at 2 Hz). This was followed with a three minute resting session with uniform, reduced illumination (800 lux) and no electrical current. Finally, the paramecia were exposed to a three minute response session with the original differential illumination but without electrical current. About 500 individual paramecia (in groups of 15-20) were counted in the training, resting and response sessions.

Chi Square analysis showed that during the training session the paramecia were attracted to the cathode without regard for the type of illumination ($p < 0.05$). During the resting session, there was no significant difference in the distribution ($p > 0.10$). In the response period, the paramecia moved to the light or dark area that was originally associated with the cathode during training ($p < 0.05$). Thus, these groups of paramecia demonstrated a learned response after a single training trial.

Current experiments are examining the duration of this memory and these results will be presented.

11. Performance of Seven Small Volume Nebulizers at Three Different Flow Rates

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Patients with respiratory diseases benefit from the delivery of aerosolized medication via a small volume nebulizer (SVN). There are many different models of SVN available that exhibit a variety of performance characteristics. **OBJECTIVE:** Investigate the rate of aerosol delivery, time to the onset of sputtering and dead volume of seven currently available models. **METHOD:** Utilizing a ventilator-driven spontaneous breathing lung model, the rate of delivery, sputter time, and dead volume were analyzed. Eighteen samples of seven currently available models were filled with 3000 mg of water and operated in groups of six at 6, 8, and 10 L/min. They were weighed initially and following each minute of aerosol production until they sputtered. Final weight was determined by running each for one minute following the minute in which each began to sputter. The weight change in each minute was divided by the number of liters of gas used during each respective minute to determine rate of delivery.

Vixone and Sidestream had the smallest dead volume depending on gas flowrate ($p < 0.05$).

At 8 L/min Salter 8900 began to sputter in the shortest time and generally produced the highest rate of aerosol delivery ($p < 0.01$). **CONCLUSION:** The design variables in the SVNs tested produced substantial differences in dead volume, nebulization time and rate of delivery. It was apparent that performance varied significantly with SVN design.

12. Detection of Sex-Specific Genomic Sequences in Cephalopods Using RAPD (Randomly-Amplified Polymorphic DNA) Analysis

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In *Octopus bimaculoides* distinct males and females exist, but there are no definitive methods to determine the sex of an animal while they are living. This obstacle can postpone the accurate interpretation of behaviors. Enlarged suckers are sometimes seen on males, but this trait is not consistent, and post-mortem dissection is required for accurate identification. Although extensive research has been conducted with this octopus, no genetic differences

between males and females have been reported. Since the number of male births is equal to female births under a variety of conditions, it is likely that sex is determined by the distribution of sex chromosomes and that genetic differences exist. Polymerase chain reaction (PCR)-based methods have been used in many species to identify differences in DNA sequences between males and females. Randomly amplified polymorphic DNA (RAPD), which uses small primers that amplify many uncharacterized sections of the genomic DNA, has been used successfully to identify sex-specific markers in rainbow trout, ostriches, asparagus plants, and other species. To search for potential sex-specific differences, DNA from male and female octopuses was isolated using an experimentally-determined protocol and analyzed with the RAPD technique. Using pooled DNA from several males or females insures that any differences noted are characteristic of the sex rather than individual variations. Through this investigation, two candidate sex-specific markers were identified, one observed only in males and the other only in females. Validation that these RAPD products represent authentic sex-specific genetic differences in octopuses will require the analysis of additional specimens.

13. Comparison of July 2007 to December 2007 Zooplankton Species off Wallops Island, Virginia

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Zooplankton samples were collected with 80 um nets between July and December 2007 at five stations between 5 km and 30 km offshore of Wallops Island, VA, to observe trends in abundance of cladocerans, tunicates, other holoplankton species and meroplankton (larvae of bottom dwelling adults). Highest abundances of all taxa were found during July to October when the coastal ocean was stratified, with exceptionally high densities noticed on Aug. 8, 2007. Meroplankton were more abundant nearshore (Station 1) than offshore (Station 5). The most abundant meroplankton species typically were larvae of adults living in sandy bottoms: *Branchiostoma* sp., *Polygordius* sp., and polychaete species. Pelagic tunicates were dominant at Station 5 compared to Stations 1 and 3. Maximum tunicate abundances were found on July 26, 2007: 184,709 per cubic meter at Station 5 compared to 209 at station 1 and 612 at Station 3. Cladocerans were most abundant nearshore. Pelagic tunicates and cladocerans can have significant grazing impacts on phytoplankton (single celled algae) because they graze on a variety of cell sizes including the abundant small taxa which are a few microns in diameter. Overall, there was high diversity of zooplankton representing six different phyla: Cnidaria, Mollusca, Annelida, Arthropoda, Chaetognatha and Chordata.

Chemistry

14. Progress Towards the Synthesis and Chemistry of Some 1,2-Diacyldiaziridines

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The overall goal of this research is to investigate the bond-breaking selectivity of the three-membered diaziridine ring. To this end, we have been attempting to incorporate strain into the ring system by decreasing the ring size from six down to three in certain 1,2-diacyldiaziridines. In order to accomplish this, appropriate 1,1-dicarboxylic acids are converted into their acid chlorides which are then coupled with a specific 3,3-dialkyldiaziridine to produce the various 1,2-diacyldiaziridines needed for this study. The chemistry and reactivity of the diaziridines can subsequently be investigated in order to determine the effects of increased strain. The results of the progress of this investigation will be presented.

15. Silver Ink: Autocatalytic Patterning of a Thin Silver Film Using Tin Chloride Sensitizer

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An activity based on the silver mirror test for reducing sugars that is suitable for introducing nanotechnology and other science concepts in the classroom is described. Students write invisible messages or drawings on glass using a tin (II) chloride sensitizer, then bring them "to life" using the silvering reaction. Silvering occurs preferentially in the sensitized areas due to the autocatalytic effect of silver nanoparticles generated by the sensitizer. The results are visually striking and the final products can kept as mementos.

16. Progress Towards the Synthesis of 1,2-Benzenedisulfonyldiaziridines

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The chemistry and reactions of 1,2-diaroyldiaziridines can be explained by invoking the intermediacy of a 1,3 dipolar azomethine imine, which results typically by breaking one of the carbon-nitrogen bonds of the three membered ring. Although the synthesis and chemistry of these compounds is well known, a thorough study on the specific and exclusive break down of one bond over another bond in the diaziridine ring has not yet been conducted. The preliminary goal of this project is to investigate this bond breaking selectivity by systematically introducing more strain into the three-membered diaziridine ring. This increase in strain should result in a more reactive diaziridine ring system. Product analyses should indicate the one specific bond that breaks preferentially. My project involves the

attempted synthesis of the novel five-membered ring analog of a 1,1-dialkyl-1,2-diaroyldiaziridine, as well as the 1,2-benzene-disulfonyldiaziridine, and to study/compare their chemical reactivities.

17. Progress Towards the Synthesis and Chemistry of Novel 1-Aryl-1*H*-diazirino[1,2-*b*]-phthalazine-3,8-diones

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A long term goal in our laboratory is to develop some novel diaziridine compounds that may be useful intermediates to make a certain class of pharmaceutical; namely, the 2,4-benzodiazepines. We plan to utilize a new approach to synthesizing specific diaziridines that may provide a more robust entry into the 2,4-benzodiazepine ring system. This new approach attempts to exploit the reaction between certain carbene intermediates with certain azo compounds to generate the "designer" diaziridines needed for this study. The results of this investigation will be presented.

18. Progress Towards the Synthesis and Chemistry of Some Novel Diaziridines

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The chemistry of 1,2-diaroyldiaziridines can be explained by invoking the intermediacy of a 1,3-dipolar azomethine imine, which results typically by breaking one of the carbon-nitrogen bonds of the three-membered ring. Several reports on the synthesis and chemistry of symmetrical 1,2-diaroyldiaziridines have appeared. As part of our research program, in order to understand how to specifically break one carbon-nitrogen bond over another, we are attempting to incorporate two different electron withdrawing substituents on the two ring nitrogens. The results of this ongoing investigation will be the subject of this poster.

Computer Science

19. Extending Microsoft's XNA Framework with BSP Content and Animation

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In Fall 2008 we began developing our own framework, the MU XNAEngine, an extension of Microsoft's XNA Game Studio, to support efficient geometry transformations; collision detection; rigid-body physics; first- and third-person cameras; and background and 3D sound. This engine is currently used by the 3D Game Programming and Animation class (CSCI 475).

We are now refining and extending the engine to handle additional model formats and animation. XNA provides a content pipeline that enables developers to import and process new types of digital content. Using the pipeline infrastructure, we have added support for the Valve Binary Space Partitioning (BSP) model format and Valve Texture Format (VTF). We have also created our own model type for processing and handling transformable geometry at a coarser granularity and higher efficiency than the native Model type, as well as a model type more conducive to blended character animation.

Earth Sciences

20. A Climatology of the Wintertime Jet Stream and Lower-Tropospheric Temperature Over the Mid-Atlantic United States Related to Global Atmospheric Oscillations

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Jet streams are driving factors for weather in the mid-latitudes. A recent study by Archer and Caldeira (2008) published in the *Geophysical Research Letters* concluded that there has been a significant change in jet stream strength and position in both hemispheres from 1979-2001. One result from Archer's and Calderia's study that is of interest to our research is that the jet stream in the Northern Hemisphere has also weakened. This study builds upon our previous research which suggested that the wintertime mid-Atlantic jet stream has weakened and shifted north. Upper air data from the Integrated Global Radiosonde Archive (IGRA) is utilized to develop a modified analysis of trends in the position and strength of the jet. The IGRA is also used to analyze trends in lower-tropospheric temperatures over the mid-Atlantic. This observational data has been analyzed in conjunction with the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO) data to show correlations between these major modes of atmospheric oscillation and wintertime lower-tropospheric temperature and the strength and position of the jet stream.

21. De-tiding Surface Current Velocities in the Lower Chesapeake Bay Using CODAR Observations

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CODAR Ocean Sensors (COS) is a new method of measuring surface ocean currents using HF-Radars. It is based on the principles of the Doppler Shift as a transmitter sends out a radio frequency and an antenna receives the backscatter from the ocean surface. NASA and Old Dominion University have deployed and collected surface current Data using the COS along the Delmarva Peninsular. Since the surface currents measured using the COS also contains the tidal component of the circulation, it is necessary to de-tide the data to extract only the currents driven by winds or density differences along the coast. Once de-tided, the currents can be used to study circulation features and associated transport of biological features and pollution along the coast. The project outline is as follows: a) Get raw data and initial programs from NASA and ODU b) Calculate and plot the surface currents c) Write and implement the code for de-tiding the data. Results of our work will be enlightened in this poster.

22. De-tiding ADCP (Acoustic Doppler Current Profiler) Data

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An ADCP is an instrument that estimates horizontal and vertical water velocities as a function of depth. It uses Doppler Effect to measure the relative velocity by sending out three acoustic beams in different directions and collecting what parts of the beam are reflected back. The ADCP is mainly used to measure ocean currents at very high spatial and temporal scales. For this research, we obtained data collected by NASA Wallops scientists from a ship mounted ADCP, off the coast of Virginia. Our initial work will involve producing vector averaged ocean currents and later we will use Harmonic analysis to remove tidal influences from the vector averaged currents. Tides tend to obscure the actual coastal current velocities that are very useful in coastal ocean circulation studies. A specific application of our work will be to understand the sources of low oxygen waters that are observed to enter the Chesapeake Bay. The low oxygen waters tend to affect marine life like Oysters and Blue Crab in the Bay. This work is a collaboration between NASA Wallops, Marine Science Consortium (MSC) and Millersville. In this poster, we will discuss our latest results and findings from this study.

23. A Statistical Comparison of Vertical Total Electron Content (TEC) from Three Ionospheric Models

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Total electron content (TEC) exhibits significant variations in both space and time depending upon latitude, longitude, solar cycle, UTC, and season; these variations can have potentially negative effects on communication and navigation systems. Recently, three models have provided accurate results in reconstructing and/or calculating real-time (or near real-time) vertical TEC values: the Utah State University Global Assimilation of Ionospheric Measurements (USU GAIM) Gauss-Markov Kalman Filter Model, the United States Total Electron Content (US-TEC) Model, and the Coupled Thermosphere Ionosphere Plasmasphere electrodynamics (CTIPe) Model. This research offers a statistical comparison of the vertical TEC outputs from the previously mentioned models on both a global and local (over the continental US) scale during the month of July 2008. We present the average difference and root mean square difference (RMS difference) for three different model comparisons (e.g. – US-TEC vs. GAIM, US-TEC vs. CTIPe, and GAIM vs. CTIPe). We have documented certain model biases and the differences measured between corresponding data points among the models relative to each comparison. Two out of the three comparisons

showed that the US-TEC model's bias predicted higher values of vertical TEC relative to the other models, while the third comparison revealed a small bias in the CTIPe model to forecast greater vertical TEC values when compared to the GAIM model. By computing the RMS difference, we can better examine the source of these biases relative to the aforementioned model comparisons. This is the first step in documenting the biases, errors, and uncertainties associated with these three models.

24. Numerical Simulation of Daytona Beach Rogue Wave of July 3-4, 1992

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During the night of July 3-4, 1992 a large, unexpected wave struck Dayton Beach, Florida, producing a run-up of 1.8 meters. The wave caused damage and injuries to vehicles and persons camping on the beach. The source of the wave was likely a southward moving squall line that resonantly forced a barotropic wave. This project is using a shallow-water ocean model forced by atmospheric pressure perturbations in an attempt to replicate the Daytona Beach wave.

Mathematics

25. Time Series Analysis: Seasonality and Intervention Analysis using R

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The Univariate Box-Jenkins ARIMA procedure provides a method to model the behavior of a time series based on current and past values of the series. This method allows for the incorporation of seasonal trends in the data. Although this method is sufficient for most time series data sets, it is sometimes the case that a time series is interrupted by an event such as a natural disaster. Intervention Analysis provides us with a method to correctly specify an ARIMA model for such a time series.

Lake Superior, located in North America, is the largest of the Great Lakes. It was found that the evaporation over Lake Superior followed a seasonal pattern. The data set analyzed included the monthly total evaporation over Lake Superior (measured in tenths of millimeters) from January 1950 through December 1998. Our final model for evaporation over Lake Superior was specified as $ARIMA(0,0,1) \times (0,1,1)_{12}$.

Hurricane Katrina in late August 2005 and hurricanes Gustov and Ike in September 2008 each had a profound effect on Louisiana's economy. It was found that these three hurricanes severely impacted the number of mass layoffs in Louisiana. The data set analyzed included the monthly number of mass layoffs in the state of Louisiana from January 1998 to January 2009. Our final model for unperturbed process was $ARIMA(1,0,0) \times (0,1,0)_{12}$ with each intervention modeled as an abrupt, temporary impact with $\delta=0$.

26. Preliminary Variance Tests for Deciding to Use Pooled vs. Non-pooled t-tests

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Detecting differences between two sample means is commonly achieved using a pooled t-test. This test is based on the assumption that the populations are normally distributed with equal variances. When the populations have unequal variances, the non-pooled t-test is used as an alternative. The problem is to decide which method to use when given data with unknown variances especially when sample sizes are not equal. Doing a preliminary F-test for equal variances is a possible solution. Unfortunately, the F test is unreliable when deviating from the normal assumption. A possible alternative is to use a robust test for equal variances before proceeding with the appropriate t-test. This paper investigates four possible approaches to the problem of which t-test to use. Level and power are investigated when sampling from various distributions and for equal and unequal variances.

Nursing

27. Perceptions of Clinical Nurse Mentoring and the Role of the Advanced Practice Nurse in the Rollout of HIV Treatment in South Africa

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Clinical nurse mentoring is unexplored in the literature. The concept has developed over the past few years in response to the great need for Western trained clinicians to share their knowledge and skills with clinicians in the developing world. This need is most evident in countries devastated by the human immunodeficiency virus (HIV). Over 1500 South Africans a day are infected with HIV. In March 2007, the government of South Africa released a new strategic AIDS plan. This plan intends to halve new infections within five years and to provide appropriate treatment, care and support to 80% of HIV positive people. This qualitative study explores the role of advanced practice nurses in the rollout of HIV treatment in South Africa. Further, it is intended to study the effectiveness of clinical nurse mentoring in training South African nurses in HIV treatment and care.

Physics

28. Predicting Tire Failure by Monitoring Tire Vibrations

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The goal of this research is to identify normal vibrational modes of a tire under normal conditions and to determine if monitoring the frequency spectrum of this vibration could predict tire failure. The normal vibrational modes are identified by striking the tire, using a microphone to collect vibrational data, and analyzing it through Fourier transforms. Several resonant and absorption frequencies have been identified, including a 200 Hz resonant wave traveling circumferentially through the air cavity. We have also identified an absorption that we suspect to be due to the “breathing mode” of the tire which absorbs between 35 and 90 Hz depending upon the air pressure. Our model predicts the absorptive frequency to be proportional to the square root of the tire pressure, but the data shows a slightly different relationship. Two louder and more highly damped resonances have been identified which seem to be related insofar that they have a similar dependence on pressure and similar attenuation. These have yet to be explained, but the fact that they attenuate much quicker than the 200 Hz frequency traveling in the air cavity leads us to believe that they may be coupled with the rubber. It is suspected that the two highly damped modes may propagate as Stoneley waves, solid-liquid interface waves traveling along the surface of the rubber.

29. Electrical Characteristics of a Photovoltaic Cell

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Renewable energy production is one of the most important topics in energy today due to increasing global energy needs and global warming. An increase use of photovoltaic (PV) cells, which directly convert sunlight into electricity, is essential for meeting this need since sunlight is clean, abundant and effectively limitless. These PV cells use wafer, typically made of crystalline silicon that are sensitive to sunlight. The main goal of this research is to determine the electrical characteristics of a PV cell by a variety of measurements including: Current-Voltage (I-V) characteristic curve, fill factor, conversion efficiency, and temperature efficiency. Measuring the electrical characterization of a PV cell is critical for determining the cell's output performance and efficiency.

30. Self- Assembled Monolayer Structures of Polystyrene Spheres

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The production of self-assembled monolayer structures of polystyrene spheres is investigated in this project. The polystyrene spheres used here are of two diameters, 500 nanometers, and 10 micrometers. In order to deposit a monolayer onto a glass slide, the solution containing the polystyrene spheres must be shaken in order to ensure that the particles do not sink. The glass slide is vertically inserted into the solution and very slowly dragged upward and out of the solution. The rate at which the slide is removed must match the evaporation rate of the solution containing the particles. Water tension is the effect that produces the self-assembled structures. As the solution evaporates, the particles are drawn together and then dry on the slide. After these slides are produced, surface plasmon resonance observations will be made. Typically, surface Plasmon resonance observations are made with a continuous metal layer on top of a glass slide. Here, I will create a discontinuous medium on the surface of the slides. In order to do this, a thin gold layer will be deposited onto the slide after the polystyrene spheres are in place. The gold layer will then be stripped from the slide and will carry the spheres with it. This will leave a lattice behind on the slide as the gold will be left in the spaces between where the spheres were sitting when they dried on the slide.

31. X-ray Observations of the Galaxy Cluster Abell 4059

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Galaxy clusters are among the largest objects in the universe. They are filled with hot, diffuse plasma that emits x-ray radiation. This project presents the examination of dark matter and its existence in galaxy clusters. Dark matter is currently undetectable by direct observation; however, it can be identified by its gravitational affect on visible matter. Archival data of galaxy cluster Abell 4059 was used in this study. It was observed with the Chandra X-ray Observatory on three separate occasions; 2000 September 24, 2001 January 4, and 2005 January 26-27. The distance is 226 Mpc away with a size of 0.207 Mpc. A spectrum was extracted and fit with a model that assumes the plasma is in thermal equilibrium. Its plasma temperature was found to be $3.61^{+0.07}_{-0.08}$ keV. X-ray gas emission and the basics of galaxy clusters are also reviewed in this paper. The virial theorem can be applied to astronomical objects that have a gravitationally bound spherical distribution of mass and are in equilibrium. It states the kinetic energy is equal to the negative of one half of the potential energy, so the total mass of the system can be determined. This virial, or total, mass of Abell 4059 was calculated to be $3.35^{+0.064}_{-0.074} \times 10^{13}$ solar masses. Mass distributions and density of the x-ray gas are examined as a function of radius. The sum of the masses of these regions results in the total mass of the x-ray gas which is found to be larger than the combined mass of the galaxies in the cluster. The difference between virial mass and the mass of the x-ray emitting gas demonstrates the existence of dark matter within the cluster. Results show the mass of the x-ray gas is 1.76×10^{12} solar masses, therefore leaving 3.17×10^{13} solar masses of dark matter.

32. Spectral Calculations for Columnar Thin Films Deposited on Periodically Decorated Substrates

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Using a morphological model of a class of nano-engineered materials called columnar thin films (CTFs) deposited on periodically decorated substrates, we compute their optical reflection and transmission spectra. The calculation procedure involves the use of the MIT Electromagnetic Equation Propagation (Meep) software libraries. The deposition geometry and the spatial periodicity affect the spectra in technologically significant ways. Our current efforts are focused on a narrowband, linear-polarization rejection filter.

33. Observation of Car Window Resonance

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Resonant harmonic frequencies occur on a daily basis. For my research, I have decided to examine the resonant harmonic frequencies of an automobile cabin and also examine the ways in which these frequencies may be driven. The most common type of driver is using an air stream while driving the car. By measuring the dimensions of the vehicle, I was able to calculate the Helmholtz frequency to be 47 Hertz. I was also able to calculate the standing wave frequency, of a tube open at both ends, to be 117 Hertz. I found the resonance of the cabin experimentally by hanging a loudspeaker in the car and I tuned the frequency. The experimental frequency was 46.2 Hertz. Another possible way to drive the harmonic system would be to drive the car down the highway with the rear windows open. This is very similar to the physics of a flute. The frequency measured with both the back windows down was 19 Hertz. I also observed a linear velocity dependence of the resonant frequency amplitude. There was also a threshold speed for the resonance of 40 miles per hour. If I record the resonance in stereo I noticed a phase shift of the pressure waves, yet this is still inconclusive.

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